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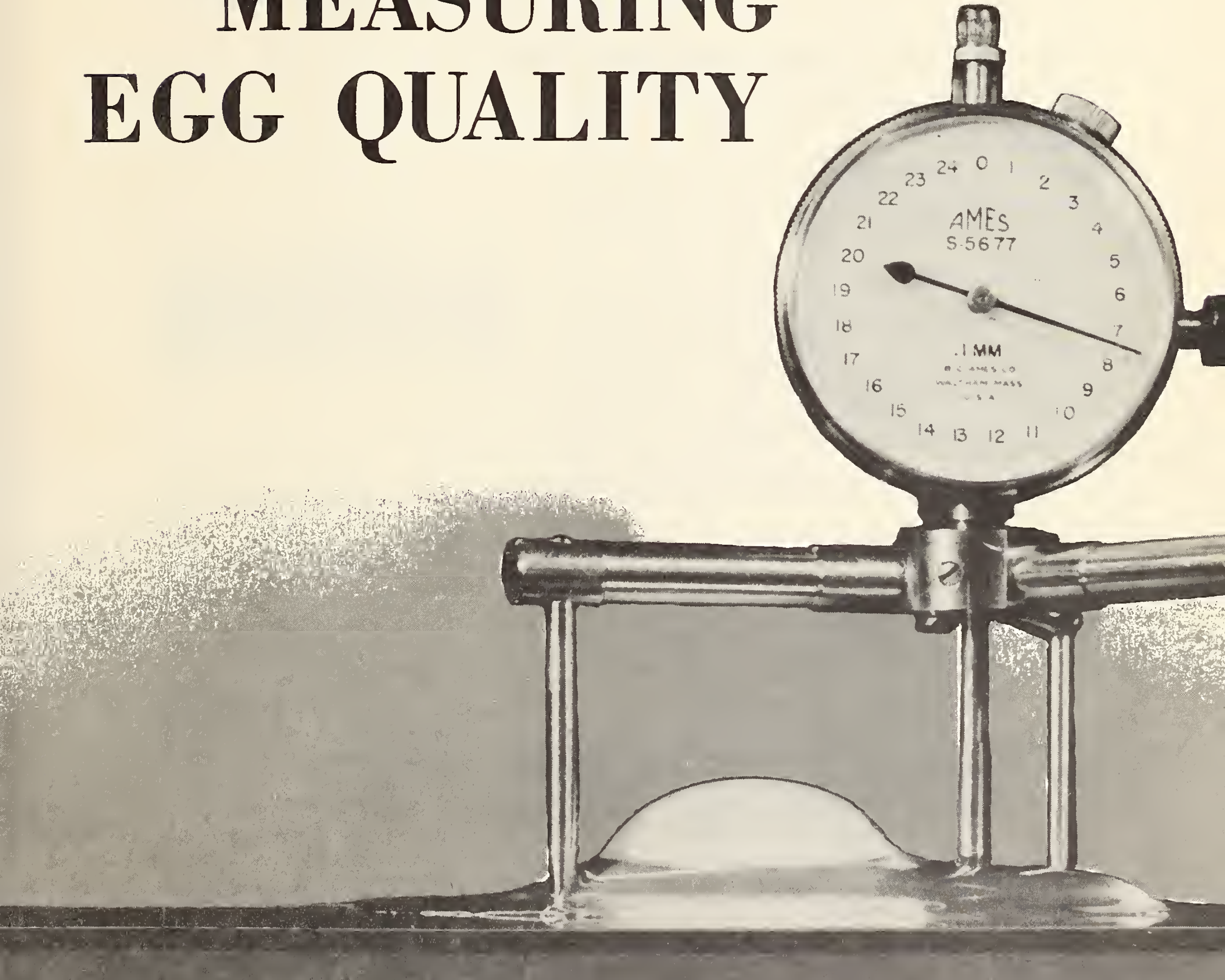
Equipment and Methods for MEASURING EGG QUALITY



U. S. DEPARTMENT OF AGRICULTURE · AGRICULTURAL MARKETING SERVICE · WASHINGTON, D. C.

POULTRY DIVISION

AMS No. 246

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June 1958

EQUIPMENT AND METHODS
for
MEASURING EGG QUALITY

By

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Albert W. Brant, Agricultural Research Service;
and Harlan L. Shrader, Federal Extension Service[1]

Introduction

The purpose of this bulletin is to describe methods and equipment suitable for use by breeders, egg producers, market men and others who are concerned with quality measurement of eggs.

For many years research workers have been experimenting with methods of determining the interior quality of eggs that are more objective than the time-honored system of segregating quality by candling.

At the present time a method of marketing a pack of uniformly high quality eggs is being developed by private and governmental marketing agencies. The crux of this plan is the use of an objective quality-measuring method, such as that described in this report, together with constant temperature and humidity controls. This new approach now seems feasible because large numbers of eggs are being produced by hens that are bred, fed, and managed in a manner conducive to the production of uniformly high quality eggs, and egg handling methods are being used which effectively retain the high initial quality.

Measuring Shell Quality

Cleanliness.--The producer has the initial responsibility for the production of clean eggs. Soiled eggs must be satisfactorily cleaned or sold at a discount. Practically all standards--Federal, State or private--require that top quality eggs be clean.

Shell texture, shape, and strength.--The market man can control these factors by removal of abnormal eggs as they move over the packaging line. The breeder, however, is concerned with reducing the number of abnormal eggs produced by his stock. He needs hens capable of forming an egg shell strong enough to carry its contents to the consumer without cracking under normal handling conditions. One easy method of estimating strength is to measure the thickness of the shell. Figure 1 shows a thickness gage[2] that, with a little modification, does the job satisfactorily. These gages were designed to measure the thickness of paper; therefore, the jaws are flat. Since egg shells are not flat it is necessary to remove the flanged tip from the upper jaw and round it off with a file or on an emery wheel. When measuring egg shells always place the rounded jaw on the inner surface of the shell.

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[1] An earlier publication "How to Measure Egg I.Q." was prepared by A. W. Brant and H. L. Shrader.

Remove a piece of shell, place it between the jaws of the gage, and read the figures on the scale. This measurement requires only a few seconds. Use samples of shell from different parts of the egg to locate the thinnest section. Many times this will be either the large or small end. If the measurements from the ends and center sections of the shell are the same, it is easier to use only the center portion. It is usually easier to leave the shell membranes on the piece of shell when measuring. In testing the shells from a certain hen be sure to take the piece of shell from about the same area each time. Shells thinner than .013 of an inch (0.34 mm.) are poor risks in market channels. Shell defects such as wrinkles, ridges, rough areas, and body checks can be recorded along with shell thickness.

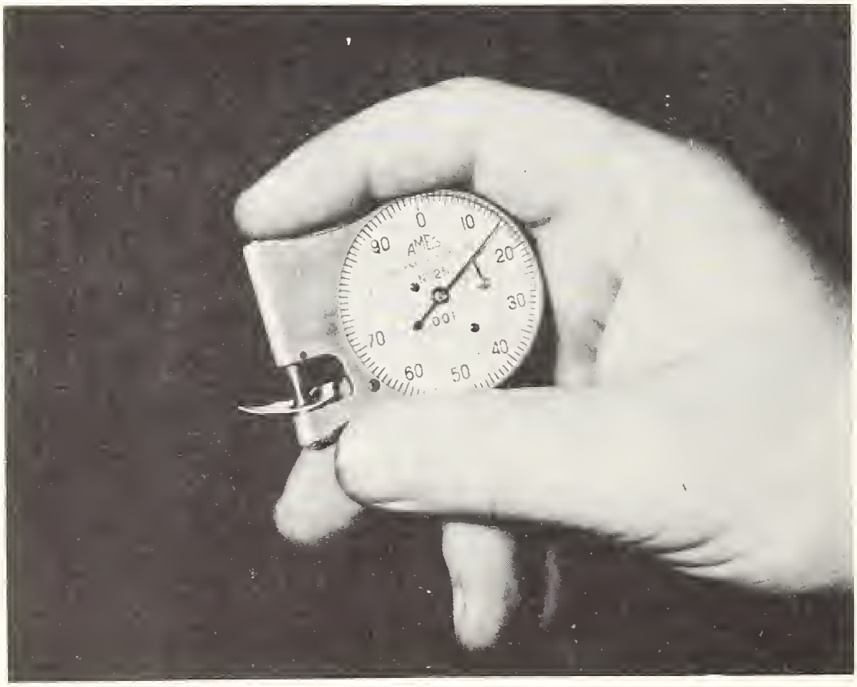

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Figure 1.--Paper thickness gage for measuring shell thickness.

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[2] The Poultry Division, Agricultural Marketing Service, Washington, D. C., will furnish names of known suppliers of this equipment on request.

Measuring Albumen Quality

Equipment.--For economy in time and preservation of the product, the following equipment should be available to persons engaged in breaking eggs for the purpose of measuring albumen height and observing yolk and albumen condition:

1. A flat glass surface approximately 10" x 10" or larger. The glass should be placed on a metal stand having adjustable legs for leveling. A mirror of approximately the same size as the glass is needed for observing the under side of the egg. The stand should be set on a table of such height that the dial of the micrometer in use will be at eye level.

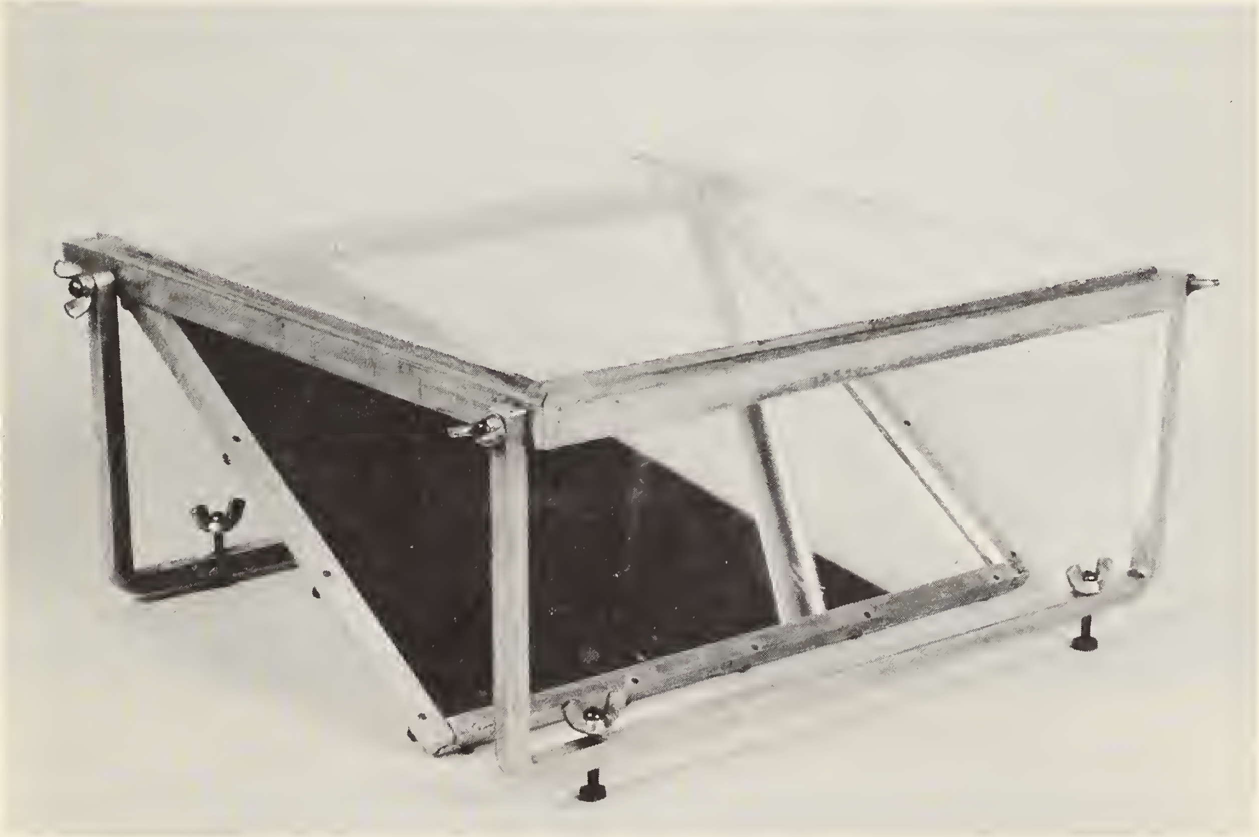

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Figure 2.--Metal stand with mirror and leveling device.

2. A standard individual egg scale which indicates the weight in ounces per dozen, or grams per egg. A test weight should be used to check the scale at the start of the breaking operation and any time the scale is moved.

3. A knife and breaking tray obtained from a supply house dealing in egg-breaking equipment is very convenient for opening the eggs.

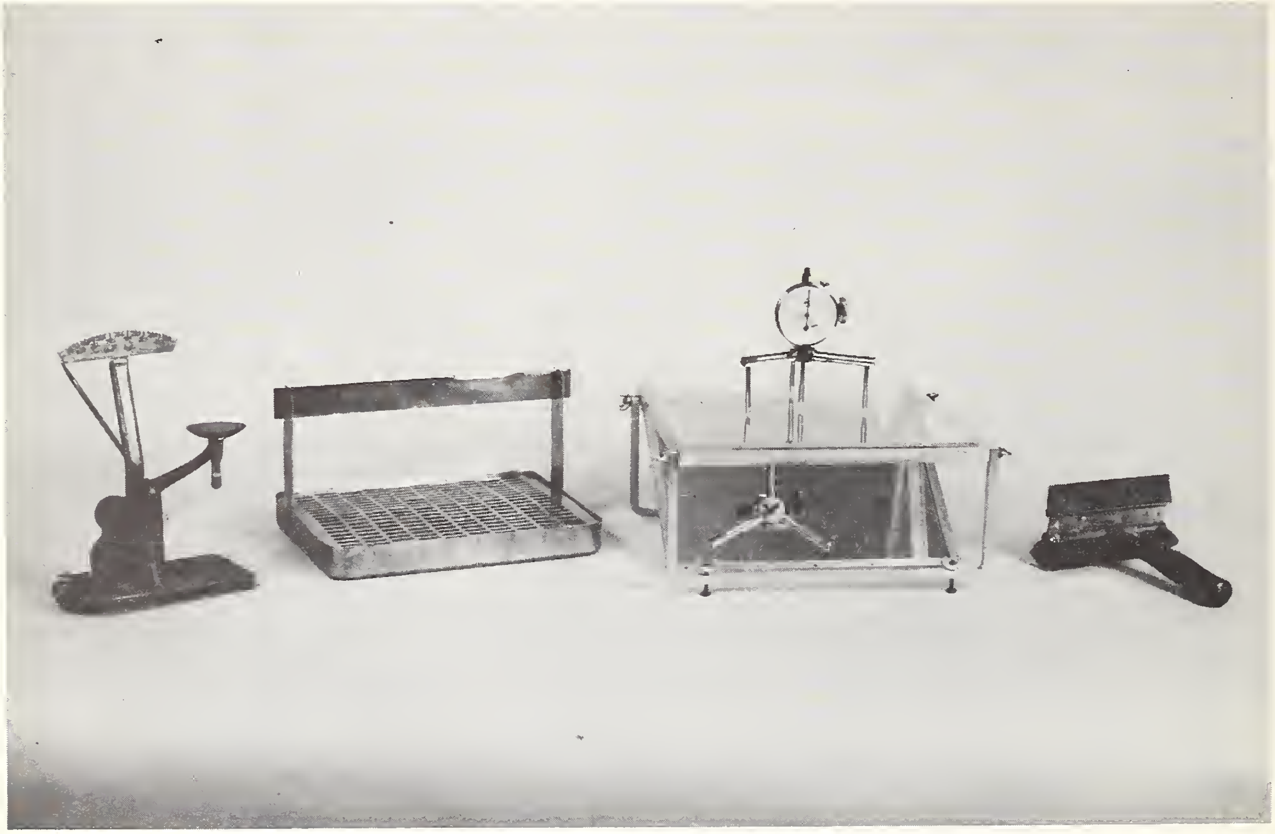

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Figure 3.--Individual egg scale, drip tray with knife, breaking stand and micrometer, squeegee.

4. A micrometer mounted on a tripod such as illustrated in figure 4 is satisfactory to measure the height of the thick albumen.[3] It should be graduated to read in tenths of a millimeter.

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[3] The Poultry Division, Agricultural Marketing Service, Washington, D. C., will furnish names of known suppliers of this equipment on request.

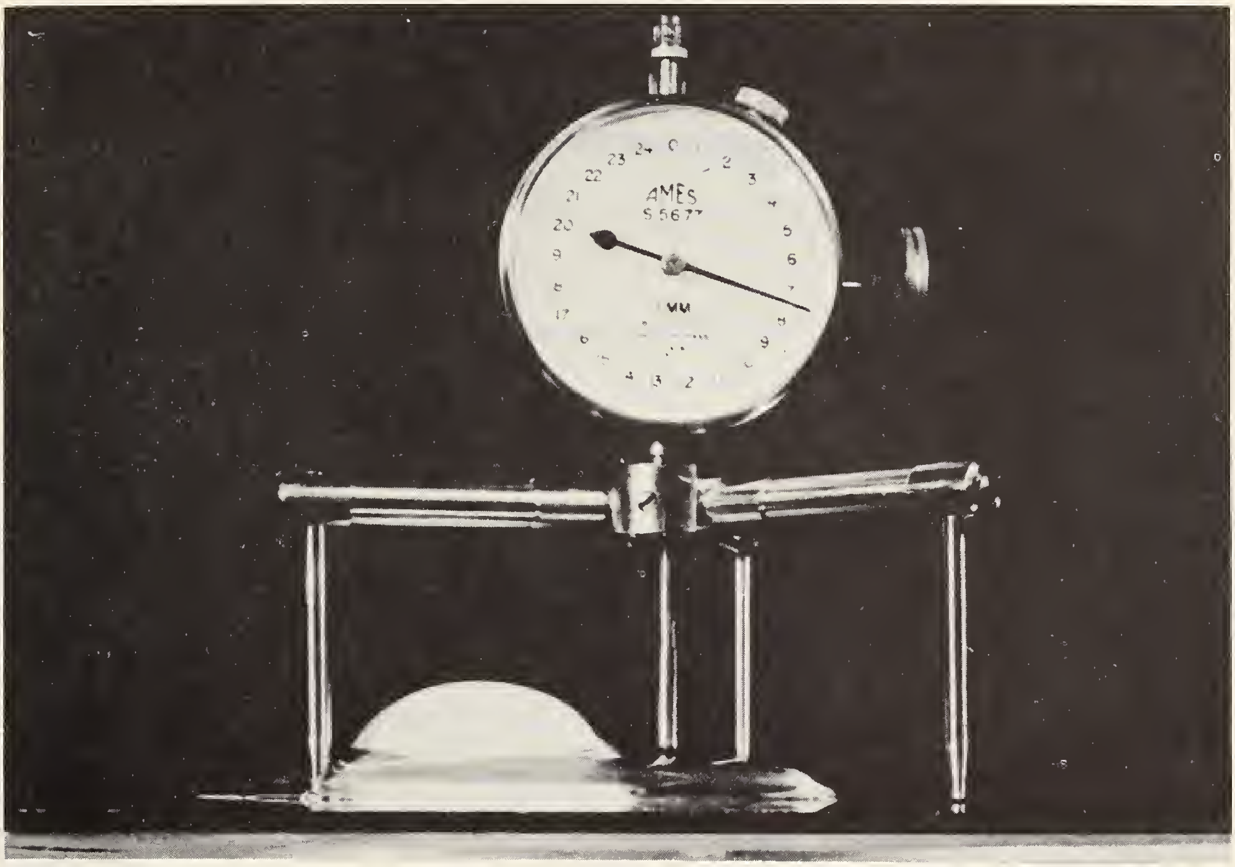

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Figure 4.--The micrometer or height gage for measuring the height of the thick white. Gage shown here in position over an egg.

5. A calculator (fig. 5) is necessary to convert the micrometer readings and egg weight into Haugh units. The Poultry Division has these available at a cost of $7.00. It is suggested that the calculator be mounted on a thin sheet of aluminum or rigid surface for ease of use.

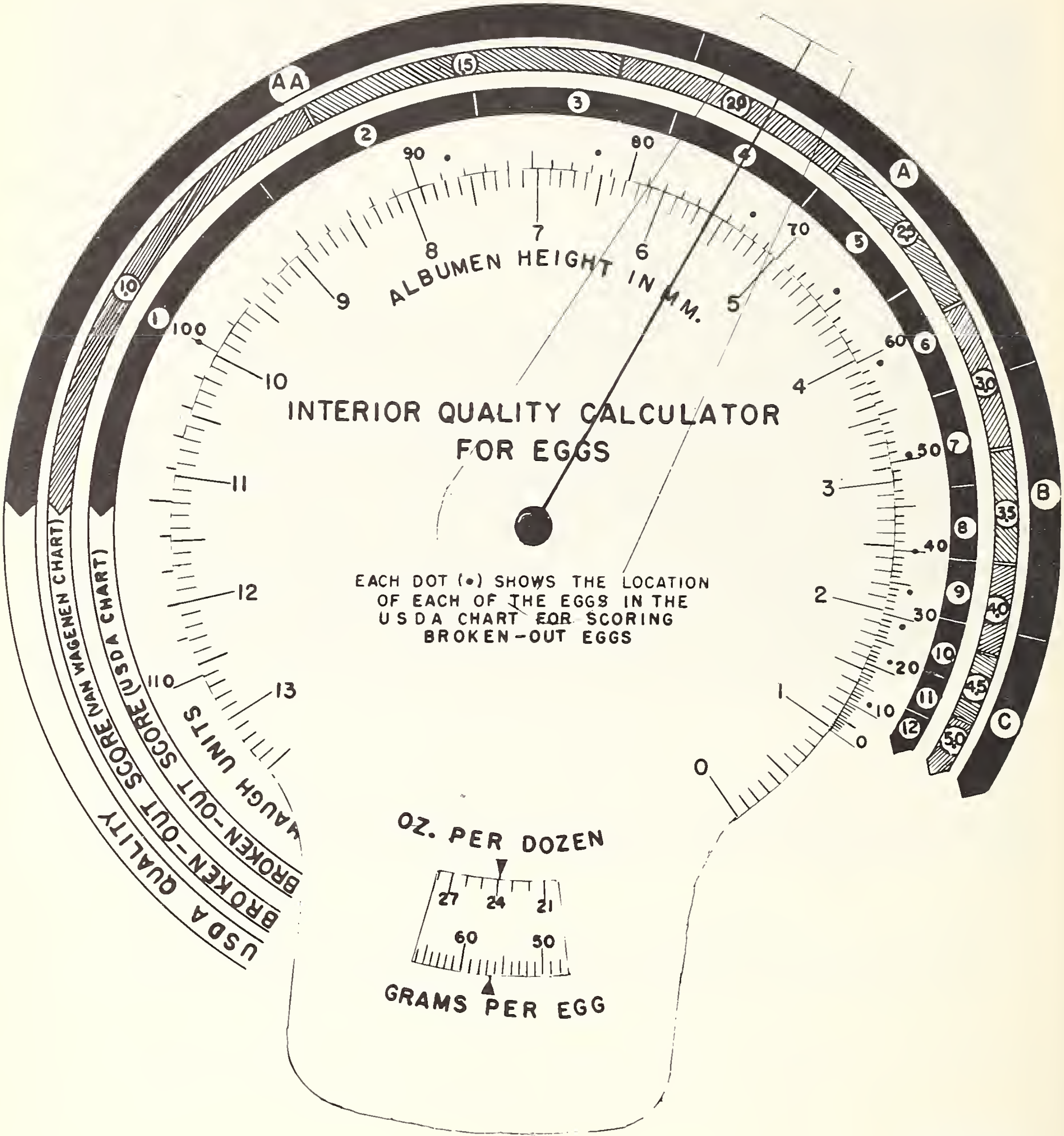
INTERIOR QUALITY CALCULATOR FOR EGGS
ALBUMEN HEIGHT IN MM.
EACH DOT (•) SHOWS THE LOCATION OF EACH OF THE EGGS IN THE USDA CHART FOR SCORING BROKEN-OUT EGGS
HAUGH UNITS
BROKEN-OUT SCORE (USDA CHART)
BROKEN-OUT SCORE (VAN WAGENEN CHART)
USDA QUALITY
AA
A
B
C
OZ. PER DOZEN
27
24
21
60
50
GRAMS PER EGG
0
1
2
3
4
5
6
7
8
9
10
11
12
13
100
90
80
70
60
50
40
30
20
10
110
0
1
2
3
4
5
6
7
8
9
10
11
12
10
15
20
25
30
35
40
45
50

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Figure 5.--The interior quality calculator for eggs. The Haugh units are calculated from albumen height and egg weight. It also shows the relationship of Haugh units to USDA scores, Van Wagenen scores, and USDA qualities.

6. A squeegee is handy to move the broken egg from the glass surface to a suitable container.

7. Liquid containers, churning equipment, and holding facilities are needed in accordance with the disposition made of the broken-out eggs.

Procedure.--Comparable results can be obtained only if uniform procedures are used.

Since eggs for top quality must have practically normal shells, only such eggs are to be selected when obtaining the sample for condition examination of albumen and yolk. The eggs should be cooled or tempered to a uniform temperature. It is generally agreed that eggs should be cooled at the farm to 60° F. or below and that the temperature should not be permitted to rise above that through the marketing channels.

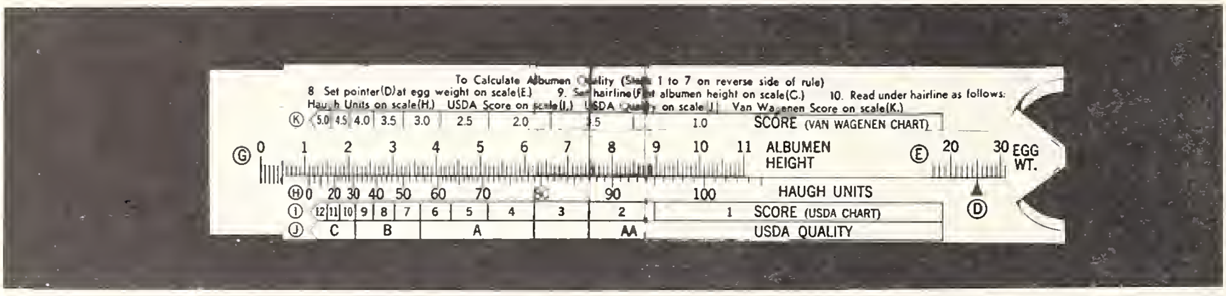
The egg must be weighed and the weight recorded to the nearest gram or half ounce, depending upon which type of scale is used.

Care must be taken in using the breaking knife so that the thick white is not ruptured. Consistent results can best be obtained by using a breaking knife. Blunt edges, such as a table edge, may cause splintering of the shell with the possibility of puncturing the thick white. The egg should be held as near the glass as possible and the contents emptied very gently from the shell. In some eggs the envelope of thick white is rather firmly attached to the shell membrane in the small end of the egg. Rupture of the thick white can generally be prevented by slowly raising the half shell. Albumen heights should not be recorded of eggs when the thick white has been mechanically ruptured or when the yolk membrane is ruptured for any cause.

The surface on which the egg contents are placed must be level. One egg at a time should be broken since it is important to measure the albumen height immediately after breaking. A delay of a few minutes can make a difference in the Haugh unit reading.

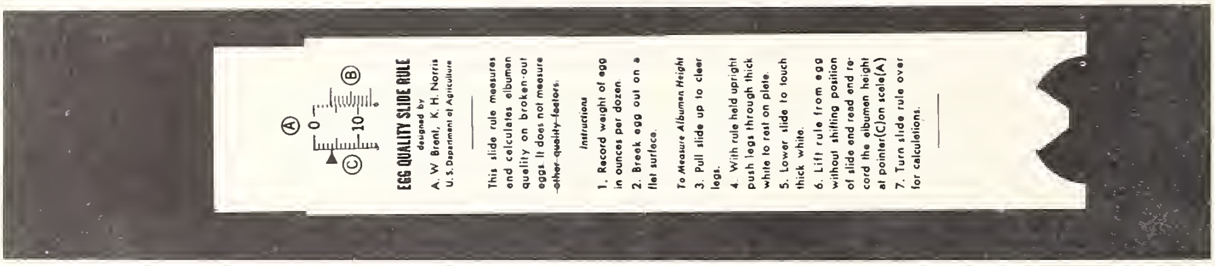
The micrometer must be checked before using. Set it on the glass and turn the measuring rod down until it touches the surface of the glass on which the broken-out egg will be placed. To be sure that the rod is actually touching the surface of the glass, push the edge of a thin sheet of paper against the intersection of the rod and the glass. The face of the micrometer is then turned so that the indicator will read zero. The procedure should be repeated from time to time during the breaking operation to be sure that the micrometer is properly adjusted.

When determining albumen quality with a micrometer, select a flat area in the surface of the widest expanse of the thick white for measurement. Eggs with very high albumen will not have a flat surface and in such cases



To Calculate Albumen Quality (Steps 1 to 7 on reverse side of rule)

8 Set pointer(D) at egg weight on scale(E.) 9. Set hairline(F) at albumen height on scale(C.) 10. Read under hairline as follows: Haugh Units on scale(H.) USDA Score on scale(I.) USDA Quality on scale J. Van Wagenen Score on scale(K.)



This slide rule measures and calculates albumen quality on broken-out eggs. It does not measure ~~other quality factors.~~

Instructions

1. Record weight of egg in ounces per dozen.
2. Break egg out on a flat surface.

To Measure Albumen Height

3. Pull slide up to clear legs.
4. With rule held upright push legs through thick white to rest on plate.
5. Lower slide to touch thick white.
6. Lift rule from egg without shifting position of slide and read and record the albumen height at pointer(C) on scale(A)
7. Turn slide rule over for calculations.

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Figure 6.--The Egg Quality Slide Rule

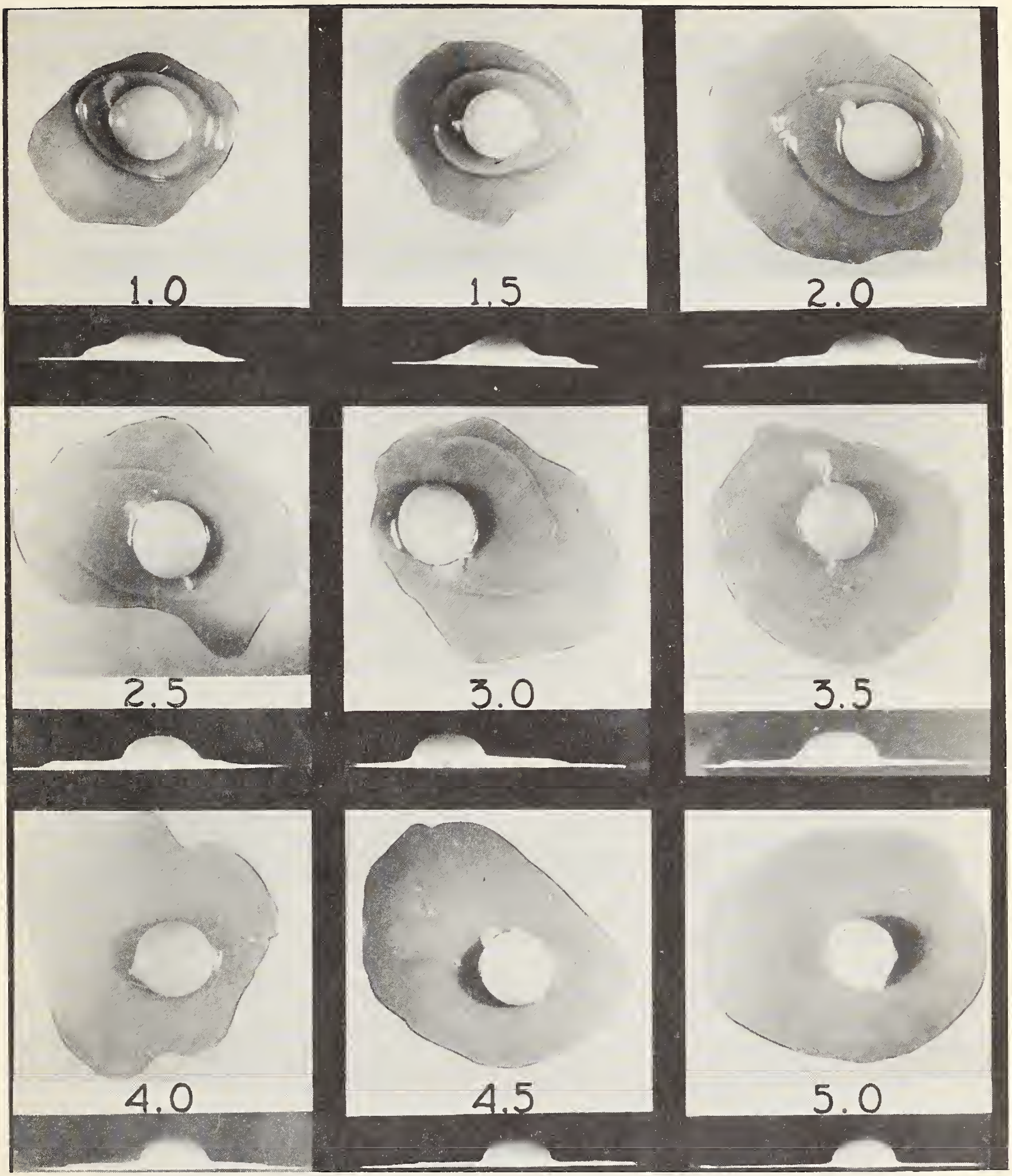

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Figure 7.--The "Van Wagenen" or "Cornell" chart showing fresh eggs of high quality in the top row, medium quality in the middle row, and low quality in the bottom row.

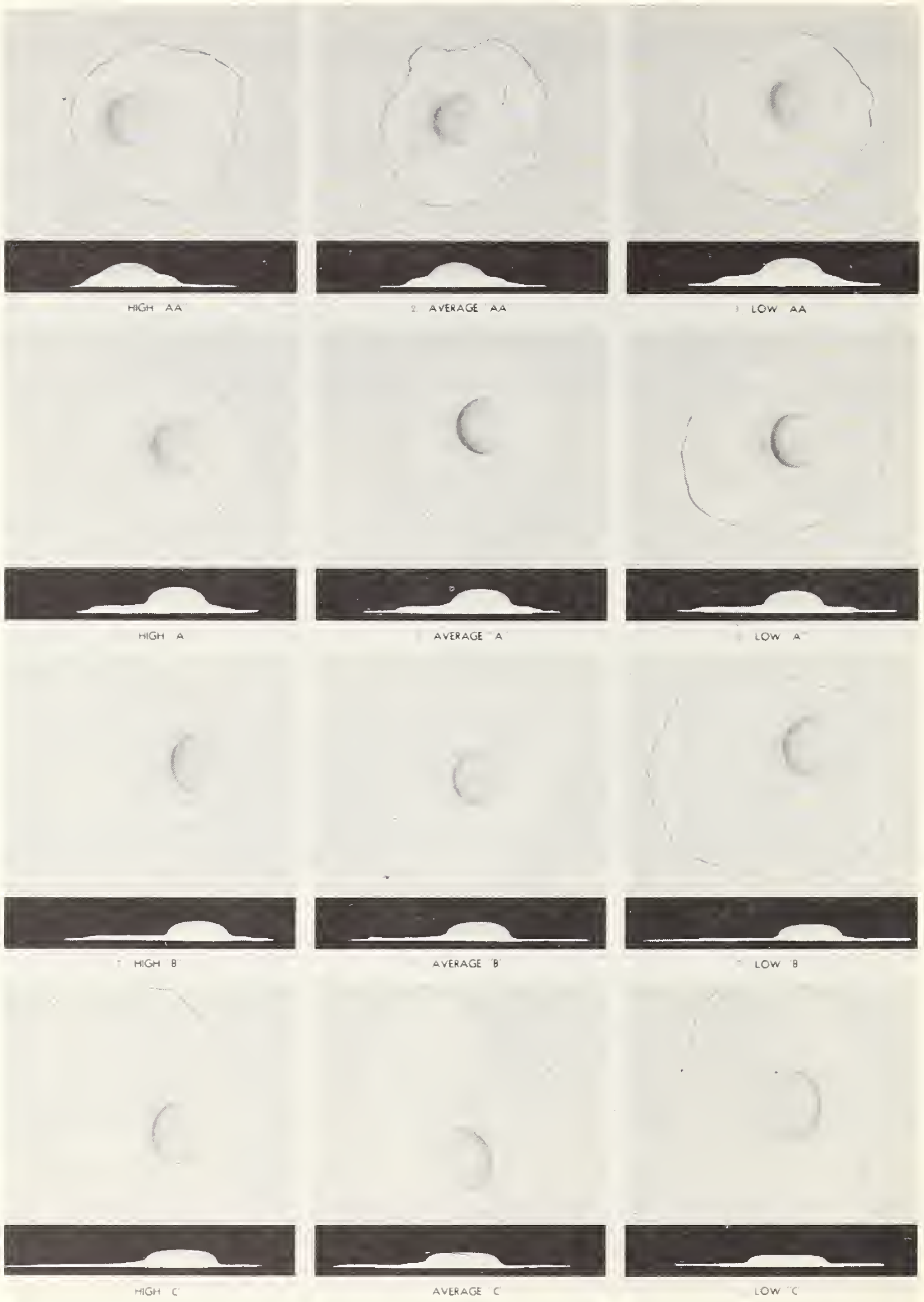

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Figure 8.--Black-and-white reproduction of U. S. Department of Agriculture color chart showing eggs by grades of interior quality specified in U. S. standards of quality.

a point about halfway between the yolk and the edge of the widest expanse of thick white should be selected. Care should be taken to avoid measuring areas over an air bubble or chalaza. The measuring rod should be rolled down slowly until it makes contact with the surface of the albumen and should be raised and cleaned before placing over the next egg to be measured.

The interior quality calculator (fig. 5) is used to determine the Haugh unit. The indicator for ounces per dozen or grams per egg is placed at a point coinciding with the weight of the egg. The pointer line is next moved to the appropriate albumen height reading and the Haugh unit reading is obtained and recorded to the nearest half. The illustration in figure 5 is that of an egg weighing 24 ounces with albumen height of 5.6 and a Haugh unit reading of 75. The egg weight, micrometer reading and Haugh unit reading are recorded on a form similar to exhibit A. This illustrates the recording of results from eggs sampled for two weeks from a producer who ships twice a week. The weekly average is transferred to a form similar to exhibit B. This carries the running average for each flock as long as it is on the program. The method of computing the weekly and running average is covered in the program requirements.

Egg quality slide rule.--The egg quality slide rule (fig. 6) is a simple, inexpensive device for measuring the interior quality of eggs, designed by Dr. A. W. Brant and K. H. Norris of the U. S. Department of Agriculture. With this plastic slide rule, one can determine albumen quality quickly. This instrument is quite satisfactory for use under other than laboratory conditions. Where large numbers of eggs are to be broken, the micrometer and the calculator will save sufficient time to make the investment in such equipment worth while. The slide rule measures the height of the thick white, and it calculates quality in four different scales according to the individual needs or preferences of the user. Haugh units, USDA quality score, USDA chart score, and the Van Wagenen-Wilgus score for condition of firm albumen are shown simultaneously. Durably made of .03-inch white plastic, with clearly printed scales and instructions, the rule is a handy-sized (1½" x 7½") instrument for checking interior egg quality.[4] Complete instructions in the use of the slide rule are sent with it.

Eye scoring method.--A reasonably accurate estimate of egg quality can be made by comparing the opened egg with the pictures as shown in figure 7. The egg should be broken onto a flat surface such as a piece of glass. Compare both the top view and the side view. The scores shown on this chart can be converted to Haugh units by referring to the calculator on page 6. The thick albumen of a high quality egg should have an outline which at least approaches the oval egg shape. The pictures shown in this figure were all made of eggs that were only a few hours old. You will note that the yolks are all round and upstanding. The pictures shown in figure 8 illustrate the recommended standards for quality for eggs meeting the U. S. standards for AA, A, B, and C qualities. These pictures were taken of eggs varying in age as found in normal distributing channels. You will note some flattening of the yolks in the lower qualities.

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[4] The Poultry Division, Agricultural Marketing Service, Washington, D. C., will furnish names of known suppliers of this equipment on request.

Meat and Blood Spots

Since the tendency to produce eggs with blood and meat spots is a heritable characteristic, breeders will want to record the occurrence of these defects. Commercial adaptation of electronic equipment with which practical results can be obtained in eliminating blood spots from market eggs is well into the final stage of development. Fairly satisfactory results are obtained, however, by flash candling.

Measuring Yolk Quality

As a general rule, the "standup" quality of the yolk in new-laid or fresh eggs is not a problem. Mottling, discolorations and other defects are sometimes encountered. An occasional hen will lay eggs with an off odor. The breeder should examine the yolk carefully and also smell the opened shell when breaking eggs and recording results. When the producer has such a problem, he should examine his feeding, management and disease control methods to see whether corrective measures can be found.

The market man who finds serious yolk defects in the broken-out eggs will not want to put that producer's eggs into a top quality pack without carefully candling each egg.

Factors to Consider in Testing Eggs

Number of eggs to measure.--It is generally considered that the breeder can make satisfactory progress by selecting 5 to 10 eggs per bird when dealing with albumen and shell quality factors.

For blood and meat spots, larger samples are needed to give a better index of the bird's performance. In general the lower the incidence the larger the sample needs to be. However, the eggs used for testing albumen quality can serve as a guide.

The most critical test of albumen and shell quality can generally be made when the hens have been in production over 12 months. A uniform procedure should be adopted, however, and it is recommended that birds being tested for breeding flocks be in production at least four months before quality determinations are made.

Statistical analysis of the quality variation found in eggs from flocks of uniform age and known heritage has shown that under controlled production and handling methods, a market man can select a very small random sample which will be highly accurate in reflecting the average quality of the lot. As small a sample as 5 to 10 eggs from a flock each week may prove large enough to assure the packer of a uniformly high quality egg after the eggs have been screened for defective shells and meat and blood spots.

Time required to test eggs.--After some practice, a fairly good operator can measure the Haugh units, measure the shell thickness, and record the blood and meat spots of 30 or 40 eggs an hour. If the operator is using the eye scoring method he may be able to do as many as 60 or 70 an hour. The operation is much more rapid when done by two operators, one to break eggs and score or measure, and the other to record the data.

Recording Results

Breeders will want to develop their own standards for selection and as a consequence their own record forms. To a certain extent, market men will also want to develop forms and sampling procedures in dealing with their producers. From a practical standpoint it is important that a current report (exhibit A) and a running average (exhibit B) report be kept of producers' eggs being delivered to the packing plant. The running average is generally computed by averaging the results of the latest four weekly entries, except that during the second and third weeks, the average is computed by averaging the latest entry with the previous entries.

Exhibit A

EGG BREAKOUT REPORT

Producer John Doe

Flock #2

Egg Temp.	No. Cases	Date Received
58° F.	12	4/1/58
60° F.	11	4/4/58
55° F.	13	4/8/58
57° F.	12	4/11/58

Date	Egg Number	Egg Weight	Albumen Height	Haugh Unit	Date	Egg Number	Egg Weight	Albumen Height	Haugh Unit
4/1/58	1	25½	7.5	86.5	4/8/58	1	26½	5.8	74.0
"	2	27	7.6	86.0	"	2	29	7.3	83.0
"	3	26	6.0	76.0	"	3	27½	7.3	84.0
"	4	28	7.5	85.0	"	4	27½	7.4	84.5
"	5	26	6.1	77.0	"	5	29½	6.5	77.0
				410.5					402.5
4/4/58	1	26	7.0	83.0	4/11/58	1	28	8.2	89.0
"	2	28	7.0	81.5	"	2	24	6.3	80.0
"	3	25	5.7	75.0	"	3	27	6.0	75.0
"	4	27½	7.8	87.0	"	4	24½	5.4	73.0
"	5	29	6.6	78.0	"	5	28½	6.9	80.5
				404.5					397.5

Date	Number of Eggs	Haugh Units	Weekly Average
4/4/58	10	815.0	81.5
4/11/58	10	800.0	80.0

Exhibit B

SUMMARY REPORT

Producer John Doe

Flock #2

Date	4/4/58	4/11/58	4/18/58	4/25/58	5/2/58					
Weekly Average	81.5	80.0	81.0	80 5	79.5					
Running Average		80.8	80.8	80.8	80.3					
Date										
Weekly Average										
Running Average										
Date										
Weekly Average										
Running Average										
Date										
Weekly Average										
Running Average										
Date										
Weekly Average										
Running Average										

Temperature and Humidity

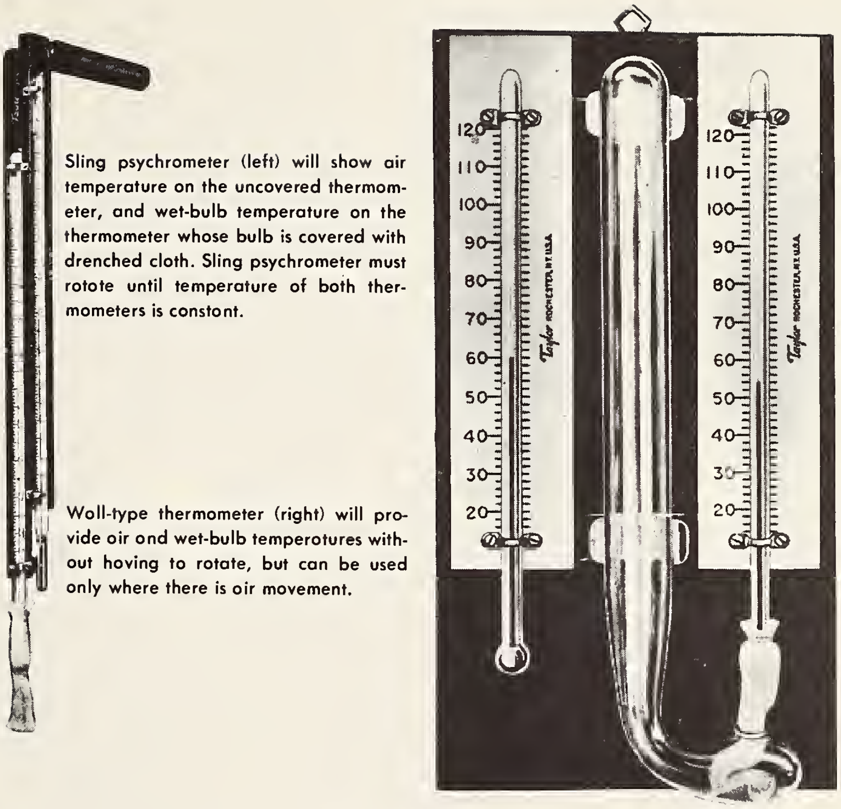
Successful operation of a quality control program depends greatly on the holding conditions at the farm, packing plant, and distributing level. Proper handling requires that attention be given to temperature, relative humidity, and dew point. These are also important factors in maintaining high hatchability rates.

Relative humidity is the ratio of the quantity of water vapor actually present in the air to the greatest amount possible at a given temperature. Complete saturation of the air is designated by 100, partial saturation is indicated by smaller numbers.

Dew point is the temperature at which the moisture in the air will condense out as liquid water. When the relative humidity is high the dew point will be nearly the same as the air temperature. When the temperature of an egg is below the dew point of the air surrounding it, moisture condenses on the egg. Such "sweating" increases the possibility of bacterial infection and may be avoided by proper temperature control.

The wet-bulb thermometer is a convenient device for measuring relative humidity. It is an ordinary thermometer with the bulb covered by a moistened wick. Care must be taken to keep the wick clean and supplied with water at all times. Distilled water is preferable. Soluble salts and dirt particles accumulated on the wick prevent it from functioning properly, causing inaccuracies in the wet-bulb readings. Wash the wicks frequently; discard and replace when the wick becomes hard.

Figure 9 illustrates a sling psychrometer and a wall-type thermometer for recording air temperatures and wet-bulb temperature.



Sling psychrometer (left) will show air temperature on the uncovered thermometer, and wet-bulb temperature on the thermometer whose bulb is covered with drenched cloth. Sling psychrometer must rotate until temperature of both thermometers is constant.

Wall-type thermometer (right) will provide air and wet-bulb temperatures without having to rotate, but can be used only where there is air movement.

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Figure 9.--Sling psychrometer and wall-type thermometer.

How to measure relative humidity and dew point.--First establish wet-bulb temperature and dry-bulb (or air) temperature with either a sling or a wall-type psychrometer. Then apply these temperatures to the psychrometric graph below to find relative humidity and dew point.

To find relative humidity: Follow vertical dry-bulb line to intersection with wet-bulb line (slanted from upper left to lower right). Intersection of the two lines gives you relative humidity on curved line.

To find dew point: After having established intersection for relative humidity, follow horizontal line to figures on the left of graph to find dew point.

Example: Suppose air temperature is 91° F. and wet-bulb temperature is 72° F. If you follow vertical air-temperature line at 91 and wet-bulb temperature line at 72, you will find they intersect at point A, indicating a relative humidity of 40 percent on the curved line. Moving from point A horizontally to figures on the left, you will find dew point at 63.7° F. For better orientation the example is enlarged in the upper left corner of the graph.

In the case illustrated in the example, water will condense on eggs when removed from storage at a temperature of 63.7° F. or colder.

Since farm eggs should be cooled to at least 60° F., packaging rooms having a relative humidity of 70 percent (wet-bulb reading of 64°) must be cooled to at least 70° F. If the relative humidity is higher, the temperature must be lowered to prevent sweating.

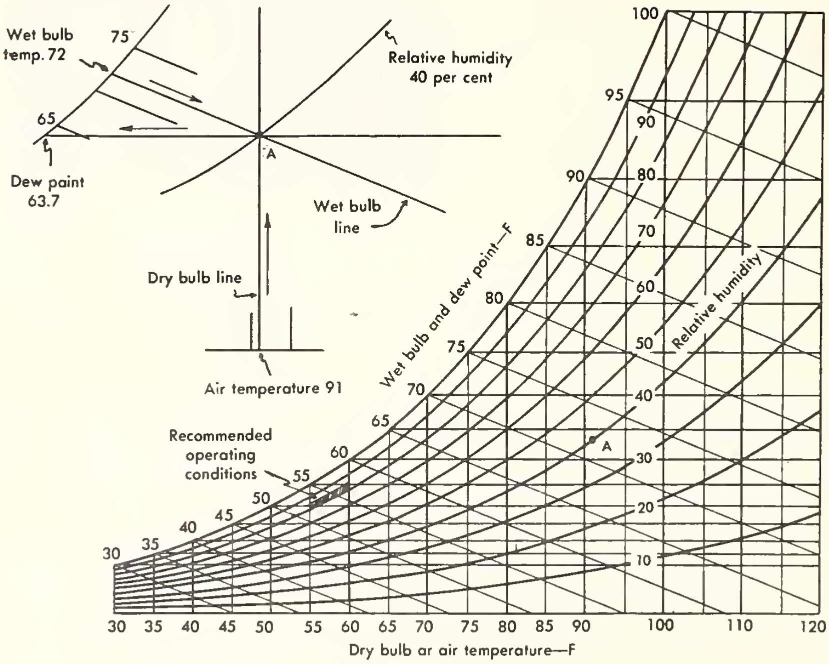

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Figure 10.--Chart for establishing relative humidity and dew point.